3-1-1970

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Admin Mgt Yes

F-57
March 1970

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This publication is a contribution from the Agricultural Experiment Station.

3/70/2M

Cooperative Extension Work in Agriculture and Home Economics
State of Indiana, Purdue University
and the United States Department of Agriculture Cooperating
H. G. Diesslin, Director, Lafayette, Indiana
Issued in furtherance of the Acts of May 8 and June 30, 1914.

Introduction

Wood has many favorable properties that contribute to its being especially suited to a multitude of home and farm needs. However, it must be protected in certain situations of use from insects and decay. The most common way to protect the wood is by impregnation with a preservative chemical. Although the most complete preservative treatments utilize heat and pressure, satisfactory results can be obtained on the wood of many species with any one of several non-pressure processes. One of the most economical and easiest to use is the cold-soak method. The wood is simply submerged in the solution and allowed to soak for a few hours or days. A variety of preservatives can be used to meet different requirements as to color, paintability of the wood so treated, freedom from odor and other properties.

This publication covers the materials, equipment and steps involved in using pentachlorophenol as the toxic chemical dissolved in number 2 fuel oil (or diesel oil), and the cold-soak method for the preservative treatment of round posts and poles for farm and home outdoor use. You are referred to Purdue Experiment Station publications listed in the appendix for information on the non-pressure preservative treatment of hardwood lumber and other wood products.

Treatability of Various Species

Adequate retention and penetration of preservative with the cold-soak method can only be obtained by treating posts and poles selected from species that are best adapted to that process. A round stock treatability classification list of some species commonly found in Indiana, which is based on a research report of the U.S. Forest Service Forest Products Laboratory at Madison, Wisconsin[1], is presented in Table 1. Note that the Classifications given in Table 1 apply to stock in the natural round condition. As a general rule, the sapwood of most species is more easily penetrated by preservatives than is the heartwood. Consequently, other things being equal, sawed timbers with sapwood removed, exposing areas of heartwood, will not treat as satisfactorily as natural round stock which has the heartwood encased in a continuous sheath of sapwood.

Preservative Solution

Pentachlorophenol, commonly called penta, is widely used in treatment solutions as a 5 per cent concentration. Standard specifications[2] for penetration and retention of preservative are based on pounds of 5 per cent solution to be absorbed by each cubic foot of wood. Penta is reasonably priced and is readily available in three forms--dry crystals, concentrated solutions and ready-to-use solutions. Purchase in dry form should probably be left for larger scale operations since extra precautions are needed in handling; and heating and agitating equipment are usually necessary in preparing solutions from the dry chemical. It is generally more convenient and economical for small quantity operations to use a concentrated solution and dilute it according to directions on the container. Various strength concentrates are available and are usually described as a ratio of parts of solvent, in this case fuel oil, to be added to 1 part of the concentrate. For example a 10 to 1 concentrate would mean that 10 gallons of fuel oil would be added to each gallon of concentrate to obtain a 5 per cent treating solution. For best results all ingredients should be weighed, but if this

[1]Treat Wood by the Cold-Soaking Method, by J. Oscar Blew. U.S. Forest Products Laboratory Report No. 1445 (Revised October, 1961).

[2]As an example, Federal Specification TT-W-571 requires a minimum 5 per cent pentachlorophenol retention of 6 pounds per cubic foot and a penetration of not less than 85 per cent of the sapwood depth for round pine fence posts.

Table 1. Some wood species commonly found in Indiana listed according to suitability for treatment as posts and poles by the cold-soak method with a soaking period of 48 hours or longer

Softwood	Hardwood
Fair to good retention and sapwood penetration	
Pine*: Eastern white	Oak: White
Jack	Bur
Red	Red
Shortleaf	Black
Slash	Sycamore
Poor to fair retention and sapwood penetration	
Red cedar, eastern	Ash: Green
White cedar, northern	White
Tamarack (Eastern larch)	Aspen
	Beech
	Birch, yellow
	Boxelder
	Butternut
	Catalpa
	Cherry, black
	Cottonwood, eastern
	Elm: American
	Rock
	Slippery
	Hackberry
	Hickory: Mockernut
	Shagbark
	Honeylocust
	Locust, black
	Oak: Blackjack
	Post
	Sassafras
	Sweetgum
	Willow

*Pines occur in Indiana mostly in plantations. A notable exception to this is Virginia pine, which is found in natural stands in southern Indiana. Generally, any pine species to be found in Indiana can be readily treated by the cold-soak method.

isn't possible, an accurate liquid measure can be used if the percentage of preservative in the concentrate and the respective weights per gallon of the concentrate and fuel oil are known. In the event a concentration of treating solution other than that for which mixing instructions have been given is desired, or if complete instructions for preparing a 5 per cent treating solution from the concentrate are missing, the proper proportions of concentrate and fuel oil to be used can be determined by using one of the following formulas:

1. Weight of fuel oil to be added to each pound of concentrate:

$$W = \frac{a - b}{b}$$, where

W = pounds of fuel oil to be added per pound of concentrate
a = decimal expression for strength of concentrate which is being diluted
b = decimal expression for strength of treating solution which will be used.

Example:

If a 10 per cent concentrate is to be diluted and a 5 per cent treating solution is desired, the weight of fuel oil to be added to each pound of concentrate would be,

$$W = \frac{.10 - .05}{.05} = 1$$ pound of fuel oil to be added to each pound of 10 per cent concentrate.

2. Gallons of fuel oil to be added to

each gallon of concentrate:

$$G = \frac{a - b}{b} \times \frac{c}{d}$$, where

G = gallons of fuel oil to be added per gallon of concentrate

a = decimal expression for strength of concentrate which is being diluted

b = decimal expression for strength of treating solution which will be used.

c = weight per gallon of concentrate

d = weight per gallon of fuel oil

Example:

If a 45 per cent concentrate weighing 8.8 pounds per gallon is to be diluted with fuel oil weighing 7 pounds per gallon to obtain a 5 per cent treating solution, the number of gallons of fuel oil to be added to each gallon of concentrate would be,

$$G = \frac{.45 - .05}{.05} \times \frac{8.8}{7} = 10$$ gallons of fuel oil to be added to each gallon of 45 per cent concentrate.

The penta concentrate may be purchased from most hardware or farm supply stores in gallon, drum or carload quantities. Your county Extension office can also supply a list of local retail and wholesale outlets.

Penta concentrate will readily mix with diesel fuel, domestic fuel oil, or any of the lighter solvents[3]. Used crankcase oil should not be used as a carrier because it usually is too thick to penetrate effectively and might contain materials injurious to livestock. The easiest and simplest way to mix or add to the solution already in the treating tank is to dump both the concentrate and carrier in proper amounts into the tank and stir well to insure the penta being thoroughly distributed throughout the solution. Unused solution will not deteriorate and can be stored for future use.

While penta solutions are among the safest wood preservatives to handle, a minimum of care should be taken in their use. Avoid direct contact of the solution with the skin and eyes to prevent possible severe chemical burns. If skin contacts the solution, wash thoroughly with soap and water. Rubber gloves and goggles should be worn in handling material to and from the treating tanks although ordinary exposure to wood that has been allowed to air-dry for a few days after treatment is not harmful to animals or humans.

Measuring and Controlling the Treatment

In addition to absorption of solution in specified amounts, good penetration of a wood preservative is required to adequately protect the wood from decay and insects. In some species, 1/4-inch penetration might be the maximum obtainable after several days' soaking. This will afford minimum protection if the penetration forms a complete ring around the inner wood and if this ring is not broken by cutting or splits and checks from further seasoning of the piece. The minimum uniform penetration that will give good protection under most conditions of soil contact is 1/2 to 3/4 inch. A good estimate of the average penetration being obtained in a particular lot of material may be had by sawing a few posts in two at the ground line. This is

[3]If the treated product is to be painted, use a clean oil such as naptha, mineral spirits or a high grade stove oil to dilute the concentrate which should also have a light oil carrier.

the zone that needs tha most protection, and penetration is not apt to be increased at this point by absorption from the end. The treating schedule can then be regulated according to the time it takes to get the required penetration, or with some species, the maximum obtainable. An increment borer or bit and brace can also be used to check penetration. If these instruments are used, the holes should be filled immediately by tightly fitting treated plugs. The presence of solution in areas that have been treated is easily detected if a dark oil is used or if an oil soluble dye is dissolved in the preservative solution.[4]

A rate of absorption or retention of 6 pounds of solution per cubic foot of wood for posts and 8 pounds per cubic foot of wood for poles is usually recommended for farm use. This may not always be possible to obtain in some species with the cold-soak method. Treatability of hard to treat species is often improved by making incisions in the wood surface. Numerous small incisions made with easily made incising tools (Figure 1) let preservative solution penetrate through glazed sap and strips of inner bark and otherwise increase flow of preservative along the grain (up and down the tree). Where incising is necessary, it should be done over the entire surface of the post or pole 1 foot above and below the ground line. A retention of only 4 pounds per cubic foot with adequate uniform penetration will also give good protection in some cases. In any case, good retention does not offset poor penetration, and if possible, select the more easily treated species for use with the cold-soak process (Table 1).

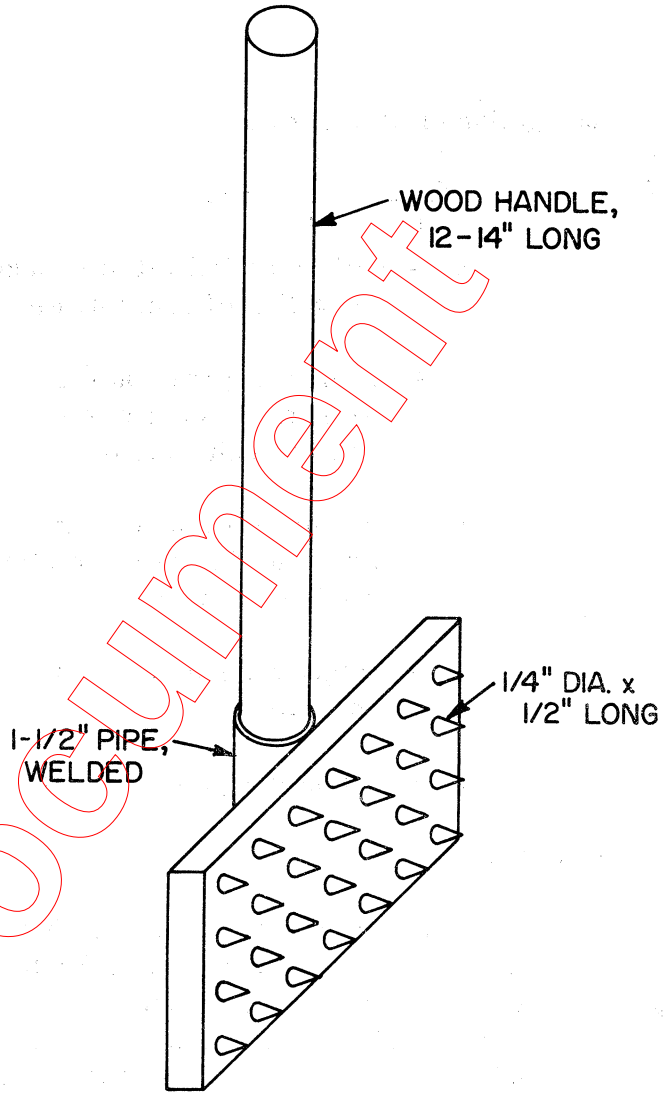

Figure 1. An incising tool made by inserting sharpened spikes which project 1/2 inch in holes drilled 3/4 inches apart in steel block 1/2" x 3" x 5". Weld may be used to fasten handle and to secure spikes from back side if holes are drilled completely through block.

As the material soaks and preservative is absorbed into the wood, retention can be easily checked by recording the amount of solution that must be added to maintain the original level in the treating tank. Number of gallons added, multiplied by the per gallon weight of the treating solution and divided by the number of cubic foot of wood being treated will yield average pounds of solution absorbed by each cubic foot of wood.

[4]For clean treatments where dark or colored oils can't be used, the presence of penta may be determined by an inexpensive solution called Penta-Check. This was developed and is sold by Wood Treating Chemicals Co., 5137 Southwest, St. Louis, Missouri, 63110.

Example:

At the end of a 4-day soak period for a batch of 40 posts averaging 1/2 cubic foot of wood each, it is necessary to add 20 gallons of treating solution, which weighs 7 pounds per gallon, to bring the liquid in the tank back to the original level. What rate of absorption has been obtained in the treat so far?

$$\text{Rate of absorption} = \frac{20 \times 7}{40 \times 2} = 7 \text{ lbs/cu. ft.}$$

Another way to check retention or absorption is to weigh the entire batch of wood before and after treating. The increase in weight divided by the cubic foot volume of the treated batch of wood will give the average rate of retention. The cubic foot volume per foot of length for posts of several diameters is presented in Table 2.

Table 2. Cubic foot volume per foot of length according to average post diameter

Avg. diam., inches*	Cubic foot volume per foot of post length
4	.09
5	.14
6	.20
7	.27
8	.35
9	.44
10	.55

*Average post diameter may be estimated by adding the largest diameter of both ends and dividing by two.

The posts must be cleanly peeled with no strips of inner bark left on the surface and well-seasoned before treating. Do not treat any posts showing evidence of decay. Posts of some species become easily infected and stained when seasoning during warm humid weather. Such posts are perfectly servicable but tend to absorb preservative much faster than normal. It is best to treat stained posts in batches separate from unstained material so that a shorter soak period may be used to avoid excessive retentions. Finally, cold-soaking is best done in warm weather unless some means is used to keep the treating solution heated during cold weather. Normally, the Indiana air temperature from May 1 to October 1 will keep the treating solution warm enough for good penetration.

Treating Equipment

Soaking vats for poles can present a problem. It takes specially fabricated steel or reinforced concrete tanks to withstand the knocks and bumps sometimes given to tanks by hard to handle long and heavy material such as poles. These tanks are expensive and would only be feasible on a large quantity treat or cooperative basis.

For a few poles or a moderate quantity of posts, an inexpensive treating pit can be made with plastic film. A trench of sufficient length, 3 feet wide and 12 inches deep in the ground will make a treating tank large enough for most small-volume treating operations. Dress the sides of the trench until they are about vertical, and be sure the bottom is level and free from sharp pointed objects such as loose stones and broken bits of root. Next construct a rectangular frame of 2" by 4" material slightly longer and wider than the top outline of the trench. Place this frame over the top of the trench and nail each corner to a 1" by 2" by 12" wood stake driven in the ground at each corner of the frame. Line the pit with plastic film and fasten the top edges to the frame with 1" by 2" batten strips.

Place two or more U-shaped bumpers of 2" by 4" vertical and 4" by 4" horizontal members on top of the plastic inside the pit, 4 feet from each end and spaced along the length of the pit. Fasten the vertical members to the wood frame with nails. This keeps the posts, or poles, from touching the plastic bottom and sides which are easily punctured by slivers of wood and knots. It is advisable to round the bottom

corners of the 4" by 4" members and place a pad made of small pieces of plastic between them and the plastic lining. The plastic lining at the end of the pit is best protected by pieces of low grade plywood also fastened to the frame around the top.

Before placing treating solution in the finished tank, fill with water to test for leaks. If the level remains constant for a short period (overnight), empty the water and refill with treating solution. A rectangular wooden frame made of 2" by 2" members about 4 inches shorter than the inside pit dimensions and with two top members spaced about 12-14 inches apart should be placed on top of the posts or lumber in the preservative solution. A number of heavy objects sufficient to sink the posts or poles beneath the top of the liquid are then laid on the frame. Solid 4" x 8" x 16" concrete blocks with a wire looped around the middle to provide a handle are convenient weights.

Sections of oil drums welded together are quite often used for small treating tanks. They may be split in half forming a trough for horizontal treatment or the complete sections can be used in the upright position for vertical treatments. If used in the upright position burying the tank so that only a foot or two of its height remains out of the ground, will make the task of putting posts in and out much easier. Some means of pumping will be required so that the tank may be periodically emptied for cleaning or removal of water.

Horizontal tanks have an advantage in that they are much easier to drain. Water from condensation will accumulate in the bottom of vats, the rapidity of accumulation depending upon weather conditions and other factors. The water level must be kept below the wood being treated. Use short lengths of 2-inch pipe across the tank to keep the wood off the bottom.

A satisfactory tank may be made of relatively light gage sheet metal if a wood frame (resembling a wood crate) is built around the outside to provide the necessary strength and stiffness.

A metal stock watering tank, if the quantity of material to be treated will justify the expense, makes a very suitable vat for treating small batches of posts at one time. These tanks may be purchased in large enough sizes, have drain outlets, and are reinforced in manufacture to withstand the weight and pressure of liquids.

All tanks should have a means for keeping the posts submerged in the liquid. A system of levers, wheel devices or just plain weight of some sort (such as the concrete blocks with wire bales that were suggested for use with a soaking pit) can be used for this purpose. A tank cover will be required to keep the preservative solution free of precipitation, sticks, leaves and other debris. A cover is also required for the safety of workmen, children, pets and livestock.

Stock should be placed on a drying rack when first removed from the vat so that surface oil may drain off. A drain board can be used under the rack to catch and divert the drained oil into a container for return to the soaking tank.

Preparation of Material

Bark is virtually impermeable to liquids and must be removed to allow passage of the treating solution. It also retards seasoning, provides cover for insects and encourages decay. Posts are generally easily peeled with an ax or a piece of broken scythe blade in the spring and early summer when the cambium is soft and slippery. The operation is one of merely inserting the edge of the blade between the bark and wood and using a prying or wedging action to loosen. A garden hoe with the shank straightened or a shovel can also be used to remove bark. During other months the bark clings tightly and just about has to be shaved off with a draw knife or similar tool.

Hand peeling has the advantages of low investment for tools and the stock may be peeled in the woods immediately after the tree is cut since there is no need to pre-assemble for peeling as with a mechanical peeler. Seasoning can thus begin at once. Bark peels the easiest right after the tree has been cut, and progressively harder each day after the tree has been cut. The chief disadvantages of hand peeling are short periods of time that the bark does not cling tightly to the tree, low-rate of production, and high labor requirements. All strips of inner bark must be removed and this is quite difficult to do on some species by hand.

Machine peeling is to be preferred from the standpoint of ease of operation, quality of peeling and rate of production. However, the initial high investment limits its practicality to situations where large numbers of posts or poles are to be treated; such a purchase would be feasible where posts are treated to sell, or if several landowners were to purchase one on a cooperative basis for peeling stock to be treated for their own use. A reference list of post peeler manufacturers and various publications containing plans and suggestions for building peelers and other equipment for wood treating plants are given in the appendix.

Green peeled timber must be prepared for treatment by seasoning or drying out-of-doors. Posts and poles that are exposed to the open air, but protected from rain and snow, will dry over a period of months until they reach the air-dry condition. Length of time required will depend upon the season of the year, size of the stock and species involved. Pine cut in the spring will be seasoned for treatment by late summer whereas some of the hardwood species would require a drying period of up to a year. The required moisture content of 20 per cent or less may be accurately determined by a moisture meter. However, when a few representative posts--from a lot which has been properly stacked--begin to lose a pound or less in a week, the stock is dry enough to treat. Seasoning of posts prior to treatment is necessary for two main reasons:

(a) To remove the water in the wood and make room for the preservative.

(b) To reduce checking and splitting from drying after treating, which would break the protecting ring of treated wood and leave untreated wood exposed.

The posts should be piled in an exposed location on high well-drained ground. Low, damp sites permit slow drying and thus encourage infection from stain and decay. The stock should be open or loosely piled so that air will circulate around each piece. It is better to cross-pile alternate layers. The bottom of the pile should be raised at least a foot off the ground and surrounding grass and weeds kept cut to insure free air movement. Exposure to direct sunlight usually results in severe checking and splitting. If possible, the posts should be stacked under an open-sided shed, or the piles provided with temporary top covers made of old lumber or wood frames covered with canvas or plastic film. Plastic has been found to be very satisfactory as a cheap source of shade and protection from precipitation. A light-duty pole-type structure, very similar to pole-type buildings used on farms but with much smaller framing members and covered with plastic, may be erected to provide protection for several piles. A single layer of 6-mil thick plastic used as a roof covering has an expected useful life of 4 to 5 years. Even with protection from direct sunlight and wind, drying will be fast enough to severely crack and check some species. Oak is a good example of this. With such species it would be better to cut and peel in the fall and winter so that the material is partly seasoned before rapid drying weather comes. This would of course mean harder hand peeling. Actually no definite rules can be laid down to determine the most advantageous seasoning time and each operator must decide upon the best practice suited to his work schedule, particular location, climatic conditions and kind of timber.

In seasoning, some species will develop a glaze on the surface from sap and other causes. Stock in this condition will not be satisfactorily treated unless this glaze is broken with an incising tool (Figure 1).

Blue stain may develop in green timber in just a few days of warm humid weather. Blue stain fungi do not injure the wood, but will result in abnormally heavy absorption in some species, notably red pine. Such staining can be easily controlled by spraying freshly peeled stock with a 21 per cent solution of sodium pentachlorophenate[5]. Blue stain that develops in wood a few weeks after initial drying begins is also a warning that conditions of drying exist that are favorable to the rapid development of decay.

Other Considerations

The practicality of treating home-grown posts and poles will depend upon individual circumstances. The most serious consideration is the time or expense involved in peeling. Unfortunately, the easy peeling season comes at a time when farming operations are at a peak of activity. An alternative measure would be to cut in the easy peeling season and store the stock in farm ponds until a less busy time of the year. Posts cut in the spring and stored completely submerged in water will peel easily at any time. Post peeling machines save time and labor, but require a substantial capital investment. Mechanical peelers suited to small operations have been developed and may be built for a cost of 1200-1400 dollars. Commercially manufactured peelers range in price from 2000 dollars on up. Expenditures of this size would be feasible for a cooperative group of farmers. An individual could amortize such an investment by peeling posts for other small operators on a custom basis. Manufacturers will supply probable production rates and operating costs for their respective machines so that an estimate of cost per piece peeled can be calculated.

The expected cost of soaking tanks and other equipment can be divided by the total number of posts and poles you expect to treat--to obtain the estimated per unit cost for treating equipment.

The cost of the preservative will depend upon the quantity purchased and other factors. If the cost of treating solution per gallon (counting cost of concentrate and fuel oil to be added) is known along with the rate of retention and weight per gallon of the treating solution, the cost for solution per post can be easily calculated.

Example:

Treating solution cost	$.48/gal.
Treating solution weight	8 lbs/gal.
Retention rate	6 lbs/cu. ft.

Cost to treat
1 cu. ft. of wood = $\frac{6}{8}$ x $.48 = $.36

From Table 2, a post with average diameter of 4 inches, 7 feet long will contain .09 x 7 = .63 cu. ft.

Cost for solution
to treat above post = $.36 x .63 = $.23

The above can be used to obtain an estimate of out-of-pocket costs per post for peeling, soaking tanks, and preservative. Labor cost must be added to the above to obtain total treating cost.

[5] A trade name for this is Dowicide G, and it may be obtained in crystal form from any chemical supply house. It is dissolved at the rate of 21 pounds of crystals to 100 gallons of water, and applied to the peeled and cut surfaces until they are wet. Any sprayer, including garden type tank sprayers can be used for application.

The treating cost plus other considerations peculiar to individual situations will in the final analysis be the basis for deciding whether to treat home grown stock or to purchase commercially treated material from retail outlets.

Appendix

Partial List of Suppliers of Preservative Oils

1. Farm Bureau Cooperative elevators and supply stores
2. Lumber yards
3. Independent farm supply stores
4. Agricultural specialty suppliers

Partial List of Suppliers of Polyethylene Films

1. Farm Bureau Cooperative elevators and supply stores
2. Lumber yards
3. Independent farm supply stores
4. Agricultural specialty suppliers
5. Tractor supply stores
6. Sears-Roebuck & Co.
7. Montgomery-Ward & Co.

Partial List of Homemade and Commercially-produced Post and Pole Peelers

1. A Tight Chain Post Peeler. W.N. Darwin, January 1950, Tennessee Valley Authority, Division of Forestry Development, Norris, Tennessee, 37828.

2. A Portable Drum Post Peeler. E.M. Conway and R.L. Schnell, February 1951. Tennessee Valley Authority, Division of Forestry Development, Norris, Tennessee, 37828.

3. Hurricane and challenger post and pole peelers. Manufactured by Efurd Machine & Welding Co., Inc., Bossier City, La., 71010.

4. Hydraulic slab debarker. Manufactured by Jackson Industries, Birmingham, Alabama, 35201.

5. Morbark Debarker Co., Winn, Michigan, 48896.

Partial List of Small Non-pressure Treating Plants and Equipment Literature

1. A Mobile, Open-Tank Plant for Treating Posts and Timbers. June 1950. Tennessee Valley Authority, Division of Forestry Development, Norris, Tennessee, 37828.

2. Design and Operations of Open-Tank Timber Treating Plants. March 1953. Tennessee Valley Authority, Division of Forestry Development, Norris, Tennessee, 37828.

3. Treating Tank for Wood Preservatives. Midwest Plan No. 80001, 1958, 1 sheet. 15 cents per copy. Lake States Forest Experiment Station, St. Paul, Minnesota, 55101.

4. Small Treating Tank for On-The-Farm Applications of Wood Preservatives. J. R. Neetzel, R. L. Hossfeld, and C. K. Otis. Technical Note 454, April 1956. 2 pages. No cost. Lake States Forest Experiment Station, St. Paul, Minnesota, 55101.

5. A Small Vacuum Treating Plant. F.H. Kaufert, J.R. Neetzel, R.L. Hossfeld and L.W. Rees. Forestry Note 12, December 1952. No cost. Lake States Forest Experiment Station, St. Paul, Minnesota, 55101.

Additional Publications on Preservative Treatment of Wood Available from Purdue University.

1. A Means for Providing Treated Wood Products for Farm and Home Outdoor Use. F-45 Cooperative Extension Service, Purdue University, Lafayette, Indiana, 47907.

2. The Cold-Soak Preservative Treatment of Rough-Sawn Hardwood Lumber. Agricultural Experiment Station Research Bulletin No. 850, Purdue University, Lafayette, Indiana, 47907.